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Final Report

For

"Extrapolating Modeling Results to Like Areas"
Research Joint Venture Agreement
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Prepared
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INTRODUCTION

For a number of years researchers at the School of Forestry (now College of Forestry and Consevation), The University of Montana (UM), and USDA Forest Service – Rocky Mountain Research Station (RMRS), FSL, Missoula have been developing computer software for planning land management and transportation-related activities on a geographic and temporal basis in the presence of multiple and sometimes conflicting objectives. This computer software is named **MAGIS** that is an acronym for **M**ulti-Resource **A**nalysis and **G**eographic **I**nformation **S**ystem. This system utilizes graphical and tabular data from an external GIS, together with numeric data entered via a series of user input screens. Once the necessary data have been entered the user can build planning scenarios through a SETUP procedure, obtain a solution to the problem and then display the results in tabular or graphical form. Recent work has focused on an examination of output results from a series of planning scenarios having varying constraints, effects and objective functions applied to both representative and like areas. These areas are in fact 5th-order HUCs that were identified in a previous study. We wanted to compare the outputs from these various pre-specified planning models between the representative and like areas. If they proved to be similar then future data collection work could be greatly reduced.

Task 1. Project the results from the representative area modeled under UM/RMRS Agreement #00-JV-11222052-527 as amended to a selected number of "like" areas.

Approach:

The above-mentioned project yielded four clusters of 5th-order watersheds out of a total of 42 based on nine attributes. One "representative" area and two "like" areas were chosen within each cluster for a total of 12 watersheds. These selections were based on a territorial map that displayed scores from discriminant function 1 and 2 plotted on the y and x axes respectively. These two functions accounted for 99 percent of the total variation present in the nine attributes when considered simultaneously. The watershed having the shortest Euclidian distance to each cluster centroid was chosen as the "representative" area. The other two "like" areas were chosen at random from the remaining watersheds in each cluster. These 12 watersheds are listed in Table 1 below:

Table 1. 5th-order HUC finalists with associated acreage.

Cluster	Finalist	5th-order HUC	Area (acres)
1	Rep	1701020**212**	145,695
1	Like1	1004010**301**	166,271
1	Like2	1701020**509**	28,962
2	Rep	1701020**109**	222,378
2	Like1	1701020**104**	118,960
2	Like2	1701020**103**	100,125
3	Rep	1701020**204**	71,984
3	Like1	1003010**502**	107,798
3	Like2	1003010**310**	156,518
4	Rep	1701020**214**	25,553

4	Like1	1003010**306**	58,525
4	Like2	1003010**304**	33,141

Task 2. Build and run MAGIS and SIMPPLLE models for a selected number of "like" areas.

Approach:

Douglas fir beetle, mountain pine beetle, and stand replacing fire were identified as the dominant disturbance processes in these landscapes. In order to compare the effects of these three processes over time on the "representative" and two "like" areas within each cluster, 30 simulations were run for ten decades using SIMPPLLE (Simulating Patterns and Processes at Landscape Scales). For each of the 12 watersheds (four clusters with one "representative" and two "like" areas in each cluster), a number of graphical displays were created to show the distribution of relative acres (y-axis) [normalized to account for the fact that each watershed was substantially different in size] associated with each of the three natural disturbance processes for the 30 simulations over ten decades (x-axis).

Task 3. Statistically compare the modeled conditions for the "like" areas with those extrapolated to them from representative area.

Approach:

To facilitate comparisons (30 curves is too many to look at), an average curve was constructed for the three watersheds modeled within each cluster for each of the three disturbance processes. Examination of these plots indicated that the trajectories of the "representative" and "like" areas were NOT the same. Although there were some similar peaks and valleys the curves were not even close to being coincident. Using an MRPP statistic, significant ($p < 0.001$) differences in area proportions were observed when relative acres of each disturbance process were compared across decades between the representative and like areas over time. It can, therefore, be misleading to extrapolate modeled results to similarly classified watersheds over time. However, this is assuming no management activities. We would suspect that management activities would tend to homogenize the vegetation and cause the behavior of the three disturbance processes to be more alike over time. The pending MAGIS runs will reveal whether this hypothesis is in fact true or not.

Task 4. Build and run MAGIS and SIMPPLLE models using vegetation data possessing varying degrees of reliability.

Approach:

Upon identification of 12 5^{th}-order HUCs, work was immediately begun to gather forest-wide and area-specific data in preparation for MAGIS runs. The appropriate tables were populated with these data. Based on a document dated 1/16/02 (Magis_Scenarios_and_Comparisons.doc [see Appendix A]) that was revised on

6/10/02 (Magis_Scenarios_rev-020610.doc) decisions were made about what types of outputs to display and compare and what alternative planning scenarios would be formulated. As a result 70 effects functions (see Table 2) were considered for each of four scenarios (see Table 3). Each scenario was run six times, each run representing a different objective function (see Table 4). Therefore, each HUCs was modeled 70 x 4 x 6 = 1,680 times.

Table 2. Effects function names, units and descriptions.

Name	Units	Description
A-EbTh-1	Acres	Eco-burn and thin in period 1
A-EbTh-2	Acres	Eco-burn and thin in period 2
A-EbTh-3	Acres	Eco-burn and thin in period 3
A-EbTh-4	Acres	Eco-burn and thin in period 4
A-EbTh-5	Acres	Eco-burn and thin in period 5
A-HV-1	Acres	Harvested area in period 1
A-HV-2	Acres	Harvested area in period 2
A-HV-3	Acres	Harvested area in period 3
A-HV-4	Acres	Harvested area in period 4
A-HV-5	Acres	Harvested area in period 5
A-NoA-A1	Acres	No-action, All acres in period 1
A-NoA-A2	Acres	No-action, All acres in period 2
A-NoA-A3	Acres	No-action, All acres in period 3
A-NoA-A4	Acres	No-action, All acres in period 4
A-NoA-A5	Acres	No-action, All acres in period 5
A-NoA-F1	Acres	No-action, FS non-wild acres in period 1
A-NoA-F2	Acres	No-action, FS non-wild acres in period 2
A-NoA-F3	Acres	No-action, FS non-wild acres in period 3
A-NoA-F4	Acres	No-action, FS non-wild acres in period 4
A-NoA-F5	Acres	No-action, FS non-wild acres in period 5
ASz-LG5	Acres	Acres of large single-story in period 5
ASz-LS5	Acres	Acres of large multi-story in period 5
ASz-MD5	Acres	Acres of medium single-story in period 5
ASz-MS5	Acres	Acres of medium multi-story in period 5
ASz-PL5	Acres	Acres of pole single-story in period 5
ASz-PT5	Acres	Acres of pole multi-story in period 5
ASz-SS5	Acres	Acres of seed/sapling in period 5
ASz-VL5	Acres	Acres of very large single-story in period 5
ASz-VS5	Acres	Acres of very large multi-story in period 5
A-ECCA-1	Acres	Equivalent clear-cut acres in period 1
A-ECCA-2	Acres	Equivalent clear-cut acres in period 2
A-ECCA-3	Acres	Equivalent clear-cut acres in period 3
A-ECCA-4	Acres	Equivalent clear-cut acres in period 4
A-ECCA-5	Acres	Equivalent clear-cut acres in period 5
C-EcTh-1	1000 $	Cost of eco-thin in period 1
C-EcTh-2	1000 $	Cost of eco-thin in period 2

C-EcTh-3	1000 $	Cost of eco-thin in period 3
C-EcTh-4	1000 $	Cost of eco-thin in period 4
C-EcTh-5	1000 $	Cost of eco-thin in period 5
H_VOL_1	CCF	Harvest volume in period 1
H_VOL_2	CCF	Harvest volume in period 2
H_VOL_3	CCF	Harvest volume in period 3
H_VOL_4	CCF	Harvest volume in period 4
H_VOL_5	CCF	Harvest volume in period 5
A-HdCv-1	Acres	Hiding cover in period 1
A-HdCv-2	Acres	Hiding cover in period 2
A-HdCv-3	Acres	Hiding cover in period 3
A-HdCv-4	Acres	Hiding cover in period 4
A-HdCv-5	Acres	Hiding cover in period 5
C-NV-All	1000 $	Total present net value
C-NtVl-1	1000 $	Present net value in period 1
C-NtVl-2	1000 $	Present net value in period 2
C-NtVl-3	1000 $	Present net value in period 3
C-NtVl-4	1000 $	Present net value in period 4
C-NtVl-5	1000 $	Present net value in period 5
I-Pltd-1	INDEX	Pileated woodpecker cover in period 1
I-Pltd-2	INDEX	Pileated woodpecker cover in period 2
I-Pltd-3	INDEX	Pileated woodpecker cover in period 3
I-Pltd-4	INDEX	Pileated woodpecker cover in period 4
I-Pltd-5	INDEX	Pileated woodpecker cover in period 5
I-RISK_1	INDEX	Risk index in period 1
I-RISK_2	INDEX	Risk index in period 2
I-RISK_3	INDEX	Risk index in period 3
I-RISK_4	INDEX	Risk index in period 4
I-RISK_5	INDEX	Risk index in period 5
A-Thrm-1	Acres	Thermal cover in period 1
A-Thrm-2	Acres	Thermal cover in period 2
A-Thrm-3	Acres	Thermal cover in period 3
A-Thrm-4	Acres	Thermal cover in period 4
A-Thrm-5	Acres	Thermal cover in period 5

Table 3. Scenario constraints.

Scenario	Constraints
1	EcoThb[1] < 10%
	ECCA[2] < 15%
	HarVol[3] < 10K/15K ac
2	EcoThb < 20%
	ECCA < 30%
	HarVol < 20/15K ac
3	EcoThb < 20%
	ECCA < 30%

	HarVol < 20K/15K ac
	HdCvr[4] > 90% p1-NA
	Therm[5] > 90% p1-NA
4	EcoThb < 20%
	ECCA < 30%
	HarVol < 20K/15K ac
	C_EcoThin[6] < $.5 x Sc3-p1

[1] Ecological thinning + burning
[2] Equivalent clear-cut area
[3] Harvest volume
[4] Hiding cover
[5] Thermal cover
[6] xxx

Table 4. Objective functions

Run	Objective
1	Min Risk Period 1
2	Min Risk Period 2
3	Min Risk Period 3
4	Min Risk Period 4
5	Min Risk Period 5
6	Max PNV Period 5+5

These output values were placed in a giant EXCEL spreadsheet and a VB macro (see Appendix B for a listing of the code) was written to automatically generate 1,120 column charts, each showing the quantity of output for two 'like' areas and the associated 'representative' areas for each of the six runs. A quick visual examinations of these charts indicated that the outputs of the 'like' areas were not the same as the 'representative' area for all runs, scenarios, and effect functions. Since most of the y-axis units were acres and the total acreage associated with the 'representative' and 'like' areas within a cluster were highly variable, it was thought that transforming the y-axis units to relative units (output acres/HUC acres) would yield better results. Unfortunately this transformation did not seem to improve the situation. However one must keep in mind that the y-axis scales were highly variable and in a number of instances apparent visual differences turned out not to be statistically significant at the 0.05 significance level. Here are a few sample charts:

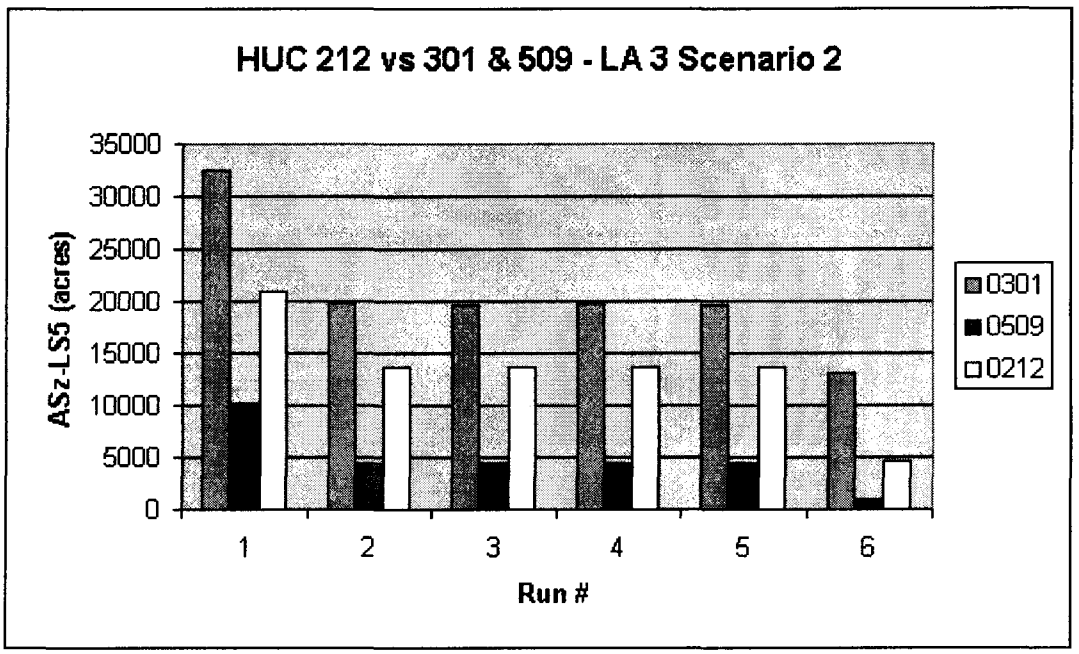

Figure 1. Acreage distribution of large multi-story stands in period 5 for 'representative' area (0212) versus 'like' areas (0301 and 0509)

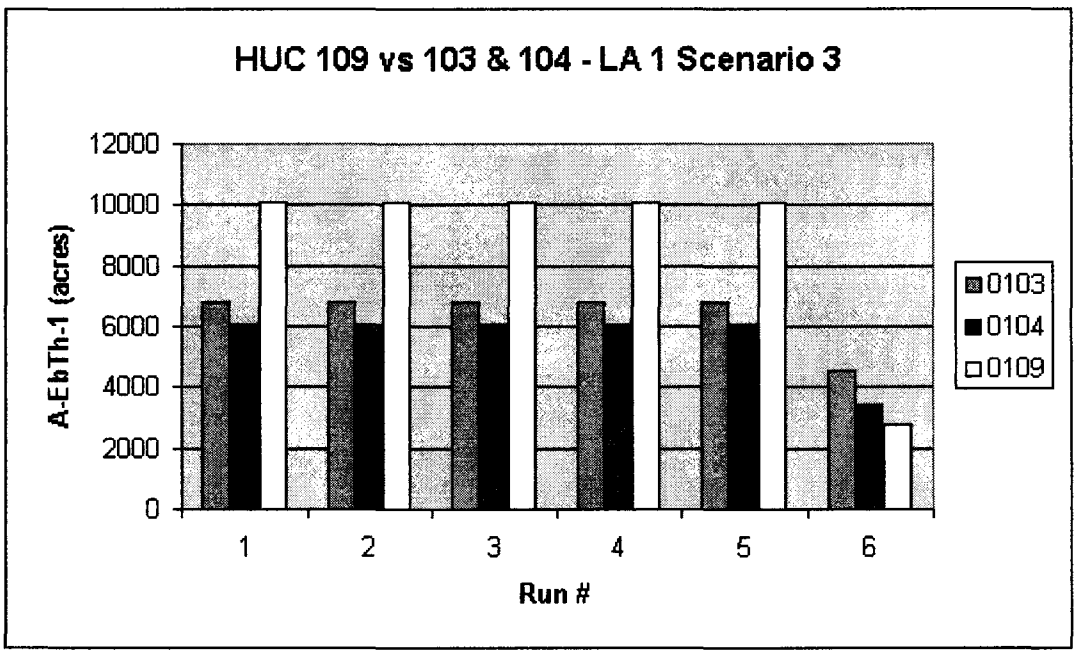

Figure 2. Acreage distribution of eco-burn and thin in period 1 for 'representative' area (0109) versus 'like' areas (0103 and 0104)

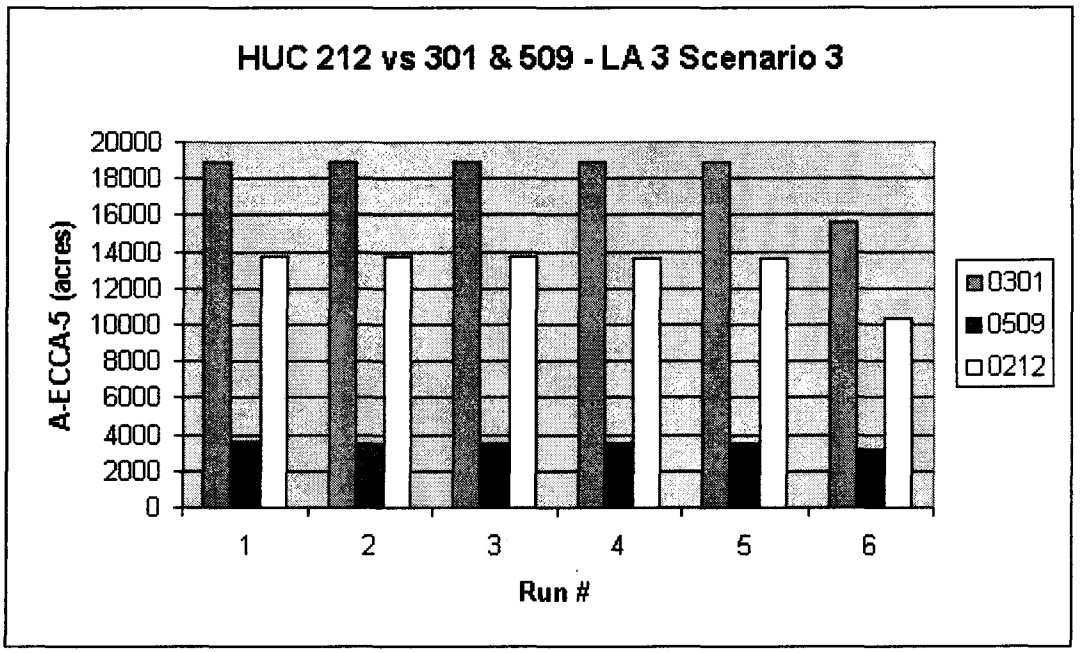

Figure 3. Acreage distribution of equivalent clear-cut acres in period 5 for 'representative' area (0212) versus 'like' areas (0301 and 0509)

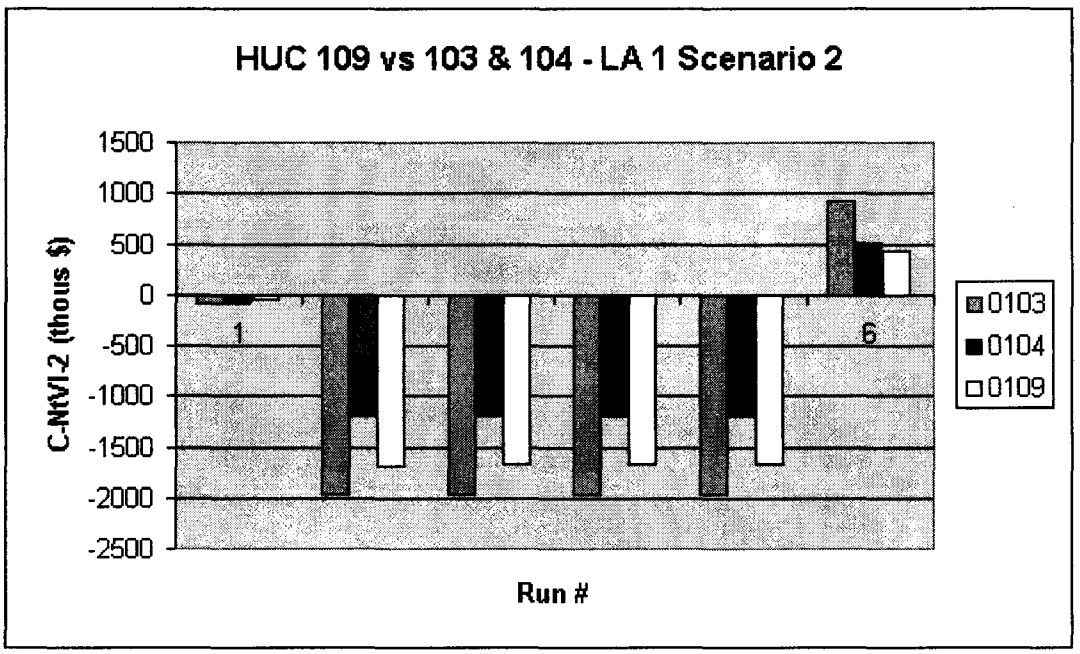

Figure 4. Dollar distribution of present net value in period 2 for 'representative' area (0109) versus 'like' areas (0103 and 0104)

Task 5. Statistically compare the differences between modeled outputs resulting from planning scenarios representing a range of vegetation data reliability.

Approach:

Assuming that the outputs were at best ordinal scale and probably not normally distributed I was probably looking at performing some kind of nonparametric tests. I finally settled on the Kruskal-Wallis test that is the equivalent of a parametric one-way ANOVA but in this case we are comparing the median outputs between three HUCs, i.e. a 'representative' plus two 'like' areas replicated over six runs. Thus the hypotheses being tested in each case was:

$$H_0: M_R = M_{L1} = M_{L2} \qquad \text{versus} \qquad H_1: \text{not } H_0$$

These tests were conducted on the outputs from **70** Effect Functions for each combination of four Like Area groups and four Scenarios for a total of **16** analyses per Effect Function output. Then the dependent variable (effect function output) was examined two ways, absolutely and relatively. The latter transformation was done because the acreages associated with the 5^{th}-order HUCs within each Like Area group varied greatly. Therefore the overall number of tests was 70 x 16 x 2 = **2,240**.

A series of 14 tables (see Appendix C) were constructed containing the asymptotic significance probabilities associated with the Kruskal-Wallis (K-W) tests for groups of Effect Function outputs, both absolute and relative. I will discuss the content of these tables first from the absolute dependent variable viewpoint followed by the relative dependent variable.

Absolute Effect Function outputs

Table 5 – *Eco-burn and Thin in periods 1 through 5*: For Eco-burn and Thin in period 1 K-W tests performed on all combinations of Like Area (LA) group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. As one examined the output differences between the 'like' and 'representative' areas generated by MAGIS for Ecoburn and Thin in period 2 through 5 they appeared for the most part to be non-significant. However as one looked at these asymptotic probabilities the number of significant values decreased, i.e. **9** for period 2, **3** for period 3, **4** for period 4, and **0** for period 5 as one went from Like Area group 1 to 4. In conclusion **14** (70%), **13** (65%), **12** (60%), and **8** (40%) of the test results out of **20** (scenario number by Effect Function output) were non-significant for LA groups A through D respectively

Table 6 – *Harvested Area in periods 1 through 5*: Again for Harvested Area in period 1 K-W tests performed on all combinations of LA group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. With two exceptions this was also true for outputs for Harvested Area in period 2. For LA group A all outputs were not significant for Harvested Area in period 4. Similarly this was true for LA group D for Harvested Area in periods three and five. For LA group B all outputs for Harvested Area in

period 5 were significant. In conclusion **9** (45%), **2** (10%), **6** (30%), and **9** (45%) of the test results out of **20** (scenario number by Effect Function output) were non-significant for LA groups A through D respectively.

Table 7 – *No action, ALL acres in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences.

Table 8 – *No action, FS non-wild acres in periods 1 through 5*: Like the previous table K-W tests performed on these five Effect Function outputs yielded significant differences for all combinations of LA group and Scenario number.

Table 9 – *Acres of large and medium single and multi-story stands in period 5*: Like the previous table K-W tests performed on these five Effect Function outputs yielded significant differences for all combinations of LA group and Scenario number with two exceptions. These were ASz-PL5 outputs for LA group B Scenario 3 and ASz-MS5 for LA group B Scenario 4 that were not significant.

Table 10 – *Acres of pole, seed-sap and very large single and multi-story stands in period 5*: For Acres of pole multi-story in period 5 (ASz-PT5) K-W tests performed on all combinations of Like Area (LA) group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. In contrast for ASz-VL5 and ASz-VS5 (very large timber in single and multi-story in period 5) all combinations of Like Area (LA) group and Scenario number yielded non-significant results meaning there was no evidence that the outputs from the 'like' and 'representative' areas were statistically different. This was due to the fact that the outputs from MAGIS for these two Effect Functions were mostly zero! For ASz-SS5 (acres of seedling/sapling in period 5) the number of significant differences between outputs from the 'like' and 'representative' areas decreased from LA group A (3) to LA group D (0).

Table 11 – *Equivalent clear-cut acres in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for A-ECCA-1 through A-ECCA-5 outputs yielded significant differences between the 'like' and 'representative' areas with a few exceptions. **6** (30%), **0** (0%), **0** (0%), and **5** (25%) of the test results out of **20** (scenario number by Effect Function output) were non-significant for LA groups A through D respectively.

Table 12 – *Cost of eco-thin in periods 1 through 5*: For Cost of eco-thin in period 1 K-W tests performed on all combinations of Like Area (LA) group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. Looking at cost differences in eco-thin from periods 3 through 5 the number of non-significant results decreased but this trend was influenced by LA group. **14** (70%), **13** (65%), **10** (50%) and **9** (45%) out of **20** (scenario number by Effect Function output) test results were non-significant for LA groups A through D respectively.

Table 13 – *Harvest Volume in periods 1 through 5*: For Harvest Volume in period 1 and 2 K-W tests performed on all combinations of LA group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different with three exceptions, one in LA group B scenario 2, another in LA group C scenario 3 and finally LA group D scenario 1. Looking at volume differences from periods 3 through 5 the number of non-significant results fluctuated but this trend was influenced by LA group. **10** (83%), **5** (42%), **8** (67%) and **7** (58%) out of **12** (scenario number by Effect Function output) test results were non-significant for LA groups A through D respectively.

Table 14 – *Hiding cover in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences.

Table 15 – *Present net value in periods 1 through 5*: For Present net value (PNV) in period 1 K-W tests performed on all combinations of Like Area (LA) group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. Looking at PNV differences from periods 2 through 5 the number of non-significant results generally decreased slightly but this trend was influenced by LA group. **15** (94%), **13** (81%), **14** (87%) and **12** (75%) out of **16** (scenario number by Effect Function output) test results were non-significant for LA groups A through D respectively.

Table 16 – *Pileated woodpecker cover in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences.

Table 17 – *Risk index in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences.

Table 18 – *Thermal cover in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences with two exceptions. These were A-Thrm-5 outputs for LA group A Scenario 4 and A-Thrm-2 for LA group C Scenario 2 that were not significant.

Relative Effect Function outputs

For the most part the Kruskal-Wallis (K-W) tests performed on the relative Effect Function outputs tended to produce higher asymptotic significance probabilities than those performed on the absolute Effect Function outputs.

Table 5 – *Eco-burn and Thin in periods 1 through 5*: For Eco-burn and Thin in period 1 K-W tests performed on all combinations of Like Area (LA) group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. As one examined the output differences between the 'like' and 'representative' areas generated by MAGIS for

Ecoburn and Thin in period 2 through 5 they appeared for the most part to be non-significant. However as one looked at these asymptotic probabilities the number of significant values decreased, i.e. **10** for period 2, **3** for period 3, **3** for period 4, and **1** for period 5 as one moves from Like Area group 1 to 4. In conclusion **15** (75%), **13** (65%), **12** (60%), and **7** (35%) of the test results out of **20** (scenario number by Effect Function output) were non-significant for LA groups A through D respectively

Table 6 – *Harvested Area in periods 1 through 5*: Again for Harvested Area in period 1 K-W tests performed on all combinations of LA group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. With two exceptions this was also true for outputs for Harvested Area in period 2. For LA group A all outputs were not significant for Harvested Area in period 4. Similarly this was true for LA group D for Harvested Area in periods three and five with one exception (LA group D scenario 1). For LA group B all outputs for Harvested Area in period 5 were significant. In conclusion **11** (55%), **5** (25%), **4** (20%), and **8** (40%) of the test results out of **20** (scenario number by Effect Function output) were non-significant for LA groups A through D respectively.

Table 7 – *No action, ALL acres in periods 1 through 5*: K-W tests performed on these five Effect Function outputs for all combinations of LA group and Scenario number yielded significant differences with the exception of LA group A scenario 1 and LA group C scenario 1 for periods 3 through 5 respectively.

Table 8 – *No action, FS non-wild acres in periods 1 through 5*: Like the previous table K-W tests performed on these five Effect Function outputs yielded significant differences for all combinations of LA group and Scenario number with the exception of LA group A Scenario 1, LA group B Scenarios 1 and 4, and LA group C Scenario 4 for periods 3 through 5, periods 4 through 5 and period 2, 4 and 5 respectively.

Table 9 – *Acres of large and medium single and multi-story stands in period 5*: Like the previous table K-W tests performed on these five Effect Function outputs yielded significant differences for all combinations of LA group and Scenario number with several exceptions. These were ASz-LG5 outputs for LA group A Scenarios 1, 2 and 4, ASz-LS5 for LA group C Scenario 2, ASz-MD5 for LA group B Scenarios 2 and 3, and ASz-MS5 for LA group B Scenarios 1 and 3 and LA group C all Scenarios that were not significant.

Table 10 – *Acres of pole, seed-sap and very large single and multi-story stands in period 5*: For Acres of pole multi-story in period 5 (ASz-PT5) K-W tests performed on most combinations of Like Area (LA) group and Scenario number yielded significant results (4 combinations were not significant) meaning the outputs from the 'like' and 'representative' areas were statistically different. In contrast for ASz-VL5 and ASz-VS5 (very large timber in single and multi-story in period 5) all combinations of Like Area (LA) group and Scenario number yielded non-significant results meaning there was no evidence that the outputs from the 'like' and 'representative' areas were statistically different. This was due to the fact that the outputs from MAGIS for these two Effect Functions were mostly zero! For ASz-SS5

(acres of seedling/sapling in period 5) the number of significant differences between outputs from the 'like' and 'representative' areas decreased from LA group A (4) to LA group D (0).

Table 11 – *Equivalent clear-cut acres in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for A-ECCA-1 through A-ECCA-5 outputs yielded significant differences between the 'like' and 'representative' areas with a few exceptions. There were a decreasing number of non-significant results from LA group A to D. Specifically, **10** (50%), **8** (40%), **6** (30%), and **0** (0%) of the test results out of **20** (scenario number by Effect Function output) were non-significant for LA groups A through D respectively.

Table 12 – *Cost of eco-thin in periods 1 through 5*: For Cost of eco-thin in period 1 K-W tests performed on all combinations of Like Area (LA) group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. Looking at cost differences in eco-thin from periods 3 through 5 the number of non-significant results decreased but this trend was influenced by LA group. **15** (75%), **15** (75%), **12** (60%) and **7** (35%) out of **20** (scenario number by Effect Function output) test results were non-significant for LA groups A through D respectively.

Table 13 – *Harvest Volume in periods 1 through 5*: For Harvest Volume in period 1 and 2 K-W tests performed on all combinations of LA group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different with one exception namely LA group B Scenario 2. Looking at volume differences from periods 3 through 5 the number of non-significant results fluctuated but this trend was influenced by LA group. **11** (92%), **8** (67%), **8** (67%) and **7** (58%) out of **12** (scenario number by Effect Function output) test results were non-significant for LA groups A through D respectively.

Table 14 – *Hiding cover in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences.

Table 15 – *Present net value in periods 1 through 5*: For Present net value (PNV) in period 1 K-W tests performed on all combinations of Like Area (LA) group and Scenario number yielded significant results meaning the outputs from the 'like' and 'representative' areas were statistically different. Looking at PNV differences from periods 2 through 5 the number of non-significant results generally decreased slightly but this trend was influenced by LA group. **15** (94%), **12** (75%), **14** (87%) and **13** (81%) out of **16** (scenario number by Effect Function output) test results were non-significant for LA groups A through D respectively.

Table 16 – *Pileated woodpecker cover in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences.

Table 17 – *Risk index in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences.

Table 18 – *Thermal cover in periods 1 through 5*: K-W tests performed on all combinations of LA group and Scenario number for these five Effect Function outputs yielded significant differences with 14 exceptions out of 80 runs. These were LA group A Scenario 1 periods 3 – 5, LA group A Scenario 2 periods 2 – 4, LA group A Scenario 4 periods 3 and 4, LA group C Scenarios 1 and 3 periods 4 and 5, and LA group C Scenario 4 periods 3 and 5 that were not significant.

Although the use of a relative dependent variable tended to produce fewer significant differences between the outputs for the 'representative' area versus the two 'like' areas for each combination of LA group and Scenario number then those using an absolute dependent variable, the outcomes were more or less the same. The outputs associated with the majority of the Effect Functions for the 'representative' area was significantly different from the 'like' areas for each combination of LA group and Scenario number. There were a few exceptions namely the outputs associated with Eco-burn and thin, Cost of Eco-thin, Harvest Volume, and Present Net Value occurring in periods 3 through 5. Here the outputs for the 'representative' area were not significantly different from those of the two 'like' areas for each combination of LA group and Scenario number. This fact seems to indicate that some time needs to elapse before the vegetation associated with a 'representative' area behaves similarly to that associated with 'like' areas. Part of this is due to the fact that the vegetation is diverse and complex and hence makes the modeling of vegetation dynamics difficult. Over time management activities tend to homogenize the vegetation and so these results tend to support that notion.

Technology Transfer

One oral presentation was given and one article was written as follows:

Ahl, R.S. and H. Zuuring. 2002. Extrapolation of Spatially Explicit Forest Processes Across Biophysically Similar Watersheds. A paper presented at the 2002 Intermountain GIS User's Conference, Big Sky, Montana, April 9 – 13, 2002.

Zuuring, H. 2002. Extrapolating Modeling Results from SIMPPLLE and MAGIS to Like Areas. In: Eco Report Winter 2001-2002. USDA Forest Service, RMRS.

Appendix A

PLAN FOR BUILDING MAGIS SCENARIOS AND STATISTICAL COMPARIONS OF PROJECTED MODEL RESULTS WITH ACTUAL MODEL RESULTS FOR:

Extrapolating Modeling Results from SIMPPLLE and MAGIS to Like Areas (January 16, 2002)

SPECIFICATIONS for SCENARIOS

Scenario 1:

a. Objective functions and MAGIS runs using the Linear Programming (LP) solution option
   - Run 1: Min Composite Risk Index for Decade 1
   - Run 2: Min Composite Risk Index for Decade 2 while holding Risk in Dec 1 to be the nearest whole number above that achieved in Run 1
   - Run 3: Min Composite Risk Index for Decade 3 while holding Risk in Decades 1&2 to be the nearest whole number above the values achieved in Runs 1 & 2 successively
   - Run 4: Max Present Net Value while holding Composite Risk Index in Decades 1, 2, 3 to be 5% above the values in Run 3.

b. Constraints applied to all runs in Scenario 1
   - Acres of Prescribed Burning and non-commercial thinning in each decade $\leq$ 10% of Forest Service non-wilderness acres
   - Accumulative Equivalent Clear Cut Acres from harvest in decade 1 $\leq$ 5% of forested Forest Service non-wilderness acres
   - Accumulative Equivalent Clear Cut Acres from harvest in decade 2 $\leq$ 10% of forested Forest Service non-wilderness acres
   - Accumulative Equivalent Clear Cut Acres from harvest in decade 3 $\leq$ 15% of forested Forest Service non-wilderness acres

Scenario 2:

a. Objective functions and MAGIS runs using the Linear Programming (LP) solution option
   - Run 1: Min Composite Risk Index for Decade 1
   - Run 2: Min Composite Risk Index for Decade 2 while holding Risk in Dec 1 to be the nearest whole number above that achieved in Run 1
   - Run 3: Min Composite Risk Index for Decade 3 while holding Risk in Decades 1&2 to be the nearest whole number above the values achieved in Runs 1 & 2 successively
   - Run 4: Max Present Net Value while holding Composite Risk Index in Decades 1, 2, 3 to be 5% above the values in Run 3.

b. Constraints applied to all runs in Scenario 1
   - Acres of Prescribed Burning in each decade $\leq$ 20% of Forest Service non-wilderness acres
   - Accumulative Equivalent Clear Cut Acres from harvest in decade 1 $\leq$ 10% of forested Forest Service non-wilderness acres

- Accumulative Equivalent Clear Cut Acres from harvest in decade 2 $\leq$ 20% of forested Forest Service non-wilderness acres
- Accumulative Equivalent Clear Cut Acres from harvest in decade 3 $\leq$ 30% of forested Forest Service non-wilderness acres

Scenario 3:

a. Objective functions and MAGIS runs using the Linear Programming (LP) solution option
   - Run 1: Min Composite Risk Index for Decade 1
   - Run 2: Min Composite Risk Index for Decade 2 while holding Risk in Dec 1 to be the nearest whole number above that achieved in Run 1
   - Run 3: Min Composite Risk Index for Decade 3 while holding Risk in Decades 1&2 to be the nearest whole number above the values achieved in Runs 1 & 2 successively
   - Run 4: Max Present Net Value while holding Composite Risk Index in Decades 1, 2, 3 to be 5% above the values in Run 3.

b. Constraints applied to all runs in Scenario 1

(Note, some percentages are listed below, but let's wait until after the Scenario 1 & 2 runs are completed to finalize these amounts. Reason to make the Hiding Cover and Thermal Cover Constraints actually constrain the solution for some decades.)

- Acres of Prescribed Burning and non-commercial thinning in each decade $\leq$ 20% of Forest Service acres
- Accumulative Equivalent Clear Cut Acres from harvest in decade 1 $\leq$ 10% of forested Forest Service non-wilderness acres
- Accumulative Equivalent Clear Cut Acres from harvest in decade 2 $\leq$ 20% of forested Forest Service non-wilderness acres
- Accumulative Equivalent Clear Cut Acres from harvest in decade 3 $\leq$ 30% of forested Forest Service non-wilderness acres
- Acres of Hiding Cover in each decade $\geq$ 10% less than the beginning Hiding Cover acres
- Acres of Thermal Cover in each decade $\geq$ 10% less than the beginning Thermal Cover acres

Scenario 4:

a. Objective functions and MAGIS runs using the Linear Programming (LP) solution option
   - Run 1: Min Composite Risk Index for Decade 1
   - Run 2: Min Composite Risk Index for Decade 2 while holding Risk in Dec 1 to be the nearest whole number above that achieved in Run 1
   - Run 3: Min Composite Risk Index for Decade 3 while holding Risk in Decades 1&2 to be the nearest whole number above the values achieved in Runs 1 & 2 successively
   - Run 4: Max Present Net Value while holding Composite Risk Index in Decades 1, 2, 3 to be 5% above the values in Run 3.

b. Constraints applied to all runs in Scenario 1

(Note, some percentages are listed below, but let's wait until after the Scenario 1 & 2 runs are completed for the rep areas to finalize these amounts. Reason to make the Cost Constraints actually constrain the solution for some decades.)

- Acres of Prescribed Burning and non-commercial thinning in each decade $\leq$ 20% of Forest Service non-Wilderness acres
- Accumulative Equivalent Clear Cut Acres from harvest in decade 1 $\leq$ 10% of forested Forest Service non-wilderness acres
- Accumulative Equivalent Clear Cut Acres from harvest in decade 2 $\leq$ 20% of forested Forest Service non-wilderness acres
- Accumulative Equivalent Clear Cut Acres from harvest in decade 3 $\leq$ 30% of forested Forest Service non-wilderness acres
- Cost of Prescribed Burning and non-commercial thinning in each decade $\leq$ $YYY (we will choose $YYY after running scenarios 1 & 2 for the rep areas)

VARIABLE to PROJECT and COMPARE

Treatment Acres:

- Acres per decade of each of the following categories of burning and non-commercial thinning activity per 1000 acres of Forest Service non-Wilderness acres

Category	MAGIS Activities
Prescribed burning	ECO_STBB, ECO_STUB
Non-commercial thinning	PRE_THIN
Non_com Thin & Rx Burn	ECOTHUB

- Acres per decade of each type of harvest activity per 1000 acres of forested Forest Service non-Wilderness acres

Category	MAGIS Activities
Commercial Thinning	COM_THIN, SAN_SAL
Selection Harvest	SC_GROUP
Shelterwood Cuts	SW_SEED, SW_FINAL
Seed Tree Cuts	ST_SEED, ST_FINAL
Clear Cuts	CC, CC_RESRV

Outputs and Economics:

- Quantity of Pileated Woodpecker Habitat Index per decade per 1000 acres of forested Forest Service non-Wilderness acres
- Quantity of Hiding Cover per decade per 1000 acres of forested Forest Service non-Wilderness acres
- Quantity of Thermal Cover per decade per 1000 acres of forested Forest Service non-Wilderness acres
- Quantity of Equivalent Clear Cut Acres per decade per 1000 acres of forested Forest Service non-Wilderness acres
- Present Net Value per 1000 acres of Forest Service non-Wilderness acres
- Cost of prescribed burning and non-commercial thinning per decade per 1000 acres of Forest Service non-Wilderness acres

Beginning Stand Structure Class Acreages:

- Compute this from the input data
- Percent of Forest Service non-Wilderness acres in each of the following stand structure classes (codes in prens are the MAGIS codes):
  - Seed/saps (SS)
  - Pole (POLE)
  - Pole, multi-story (PTS, PTU)
  - Medium (MEDIUM)
  - Medium, multi-story (MTS, MMU)
  - Large (LARGE)
  - Large, multi-story (LTS, LMU)
  - Very large (V-LARGE)
  - Very large, multi-story (VLTS, VLMU)
  - Shrub (CLOSEHERB, CL-SHRUB, OPENHERB, OL-SHRUB, OM-SHRUB, OT-SHRUB)

Ending (Decade 3) Stand Structure Class Acreages:

- Compute this from Mgt Relns pertaining to Decade 3
- Percent of Forest Service non-Wilderness acres in each of the following stand structure classes (codes in prens are the MAGIS codes):
  - Seed/saps (SS)
  - Pole (POLE)
  - Pole, multi-story (PTS, PTU)
  - Medium (MEDIUM)
  - Medium, multi-story (MTS, MMU)
  - Large (LARGE)
  - Large, multi-story (LTS, LMU)
  - Very large (V-LARGE)
  - Very large, multi-story (VLTS, VLMU)
  - Shrub (CLOSEHERB, CL-SHRUB, OPENHERB, OL-SHRUB, OM-SHRUB, OT-SHRUB)

MANAGEMENT RELATIONSHIPS NEEDED

Cost Type:

- Cost for Prescribed Burning and Non-Commercial Thinning for Decades 1, 2, & 3 (Undiscounted)

Net Revenue Type:

- Present Net Value including all costs and timber revenues over all decades (discounted)
- Present Net value including all costs and timber revenues for Decades 1, 2, & 3 (discounted)

Output Type:

- Harvest volume for Decades 1, 2, & 3
- Equivalent clear cut acres for Decades 1, 2, & 3

- Pileated Woodpecker Habitat Index for Decades 1, 2, & 3
- Hiding Cover for Decades 1, 2, & 3
- Thermal Cover for Decades 1, 2, & 3
- Composite Risk Index for Decades 1, 2, & 3

Acreage Control Type:

- Activity acres summed over all types of Prescribed Burning and non-commercial thinning for Decades 1, 2, & 3.
- Activity acres summed over all types of Harvest for Decades 1, 2, & 3.
- Management Regime acres for No Action for Decades 1, 2, & 3.
- Size Class acres for each of the following for Decade 3 (separate relns for each):
    - Seed/saps (SS)
    - Pole (POLE)
    - Pole, multi-story (PTS, PTU)
    - Medium (MEDIUM)
    - Medium, multi-story (MTS, MMU)
    - Large (LARGE)
    - Large, multi-story (LTS, LMU)
    - Very large (V-LARGE)
    - Very large, multi-story (VLTS, VLMU)
    - Shrub (CLOSEHERB, CL-SHRUB, OPENHERB, OL-SHRUB, OM-SHRUB, OT-SHRUB)

Appendix B

Visual Basic macro written to generate a series of nested column graphs

```
Sub Macro1()
'
' Macro recorded 5/29/03 by Hans Zuuring, School of Forestry
' Macro modified 6/2/03, 6/11/03, 6/16/03 by Hans Zuuring
'
'    This macro creates a series of nested column graphs for
'    the outputs from 70 different Effects Functions (EF) run
'    in MAGIS.  For the most part these EFs are grouped in sets
'    of 5 and these sets are placed in separate worksheets.
'    The outputs associated with each Effect Function are
'    run for 4 Like Area groups, each having a representative
'    a two like area HUCs.
'    For each Like Area group there are 4 Scenarios, each having
'    6 different objective functions (Run #).
'    The end result is 4 Like Area groups x 4 Scenarios = 16 charts,
'    each containing 3 HUC series over Run #, for the outputs
'    associated with each Effect Function.

  Dim Yrange(3) As String, Xrange As String, Ctitle As String
  Dim Ytitle As String, Base As String, Sname(3) As String
  Dim RN As Integer, CN As Integer, SCN As Integer, IncTop As Integer
  Dim Nchart As Integer, Cname As String, ID(3) As Integer
  Dim EF As Integer, Acode As Integer, EFrange As String
  Dim IncLeft As Integer, ChtName As String, ChtNum As Integer
  Dim Ylabel(9) As String, EFstop As Integer

  Open "C:\My Documents\SVS study -Tara Barrett\Ylables.txt" For Input As #1
  j = 1
  Do While Not EOF(1)
    Line Input #1, Ylabel(j)
    j = j + 1
  Loop
  Close #1
'
' Increment though 14 Chart Worksheets
'
  ChtNum = 0
  Do While ChtNum < 14
  ChtNum = ChtNum + 1
'  ChtName = "Charts" & Trim(Str(ChtNum))

  Acode = 70 + (ChtNum - 1) * 5    'define ASCII code for column letter
  IncLeft = -50                    'define starting X-coord of 1st graph
  Nchart = 1
```

```
    EFstop = 5
    If ChtNum = 5 Then
      EFstop = 9
    ElseIf ChtNum = 10 Then
      EFstop = 1
    End If
'
' Increment through 5 effects functions
'
    EF = 0
    Do While EF < EFstop
    EF = EF + 1          'increment Effects Function ID (EF)
'
' Define Y values column (YCN) and data range (EFrange)
'
    YCN = Acode - 64
    If Acode < 91 Then
      EFrange = Chr(Acode) & "2:" & Chr(Acode) & "7"
    ElseIf Acode > 90 And Acode < 117 Then
      EFrange = "A" & Chr(Acode - 26) & "2:A" & Chr(Acode - 26) & "7"
    ElseIf Acode > 116 Then
      EFrange = "B" & Chr(Acode - 52) & "2:B" & Chr(Acode - 52) & "7"
    End If
'
' Build Y-axis title for current effects function
'
    If ChtNum = 1 Then
      Ytitle = "A-EbTh-" & Trim(Str(EF)) & " (acres)"
      ChtName = "Charts1"
    ElseIf ChtNum = 2 Then
      Ytitle = "A-HV-" & Trim(Str(EF)) & " (acres)"
      ChtName = "Charts2"
    ElseIf ChtNum = 3 Then
      Ytitle = "A-NoA-A" & Trim(Str(EF)) & " (acres)"
      ChtName = "Charts3"
    ElseIf ChtNum = 4 Then
      Ytitle = "A-NoA-F" & Trim(Str(EF)) & " (acres)"
      ChtName = "Charts4"
    ElseIf ChtNum = 5 Then
      Ytitle = "ASz-" & Ylabel(EF) & "5 (acres)"
      ChtName = "Charts5"
    ElseIf ChtNum = 6 Then
      Ytitle = "A-ECCA-" & Trim(Str(EF)) & " (acres)"
      ChtName = "Charts6"
    ElseIf ChtNum = 7 Then
      Ytitle = "C-EcTh-" & Trim(Str(EF)) & " (thous $)"
      ChtName = "Charts7"
    ElseIf ChtNum = 8 Then
```

```
    Ytitle = "H_VOL_" & Trim(Str(EF)) & " (CCF)"
    ChtName = "Charts8"
  ElseIf ChtNum = 9 Then
    Ytitle = "A-HdCv-" & Trim(Str(EF)) & " (acres)"
    ChtName = "Charts9"
  ElseIf ChtNum = 10 Then
    Ytitle = "C-NV-All (thous $)"
    ChtName = "Charts10"
  ElseIf ChtNum = 11 Then
    Ytitle = "C-NtVl-" & Trim(Str(EF)) & " (thous $)"
    ChtName = "Charts11"
  ElseIf ChtNum = 12 Then
    Ytitle = "I-Pltd-" & Trim(Str(EF)) & " (index)"
    ChtName = "Charts12"
  ElseIf ChtNum = 13 Then
    Ytitle = "I-Risk_" & Trim(Str(EF)) & " (index)"
    ChtName = "Charts13"
  ElseIf ChtNum = 14 Then
    Ytitle = "A-Thrm-" & Trim(Str(EF)) & " (acres)"
    ChtName = "Charts14"
  End If

  ActiveWindow.Visible = False
  Windows("Like areas solns.xls").Activate
  Sheets(ChtName).Select
  Range("B2").Select

'
' Define starting Y-coord of 1st graph
'
  IncTop = -50

  LA = 0
'
' Increment through 4 like area groups
'
  Do While LA < 4
    LA = LA + 1             'increment Like Area ID (LA)
    RN = 2 + (LA - 1) * 72   'define row number (RN)
    k = 0
  Do Until k = 3
    k = k + 1               'increment HUC ID
'
' Retrieve HUC IDs within current like area group
'
    ID(k) = Worksheets("Outputs").Range("B" & Trim(Str(RN))).Value
    RN = RN + 24
  Loop
```

```
   SCN = 0
'
' Increment through 4 scenarios for each like area group
'
   Do While SCN < 4
     SCN = SCN + 1          'increment scenario ID (SCN)
   RN = 2 + (LA - 1) * 72 + (SCN - 1) * 6     'define row number (RN)
   CN = 5
   Base = "=Outputs!R"
'
' Generate X value data range
'
   Xrange = Base & Trim(Str(RN)) & "C" & Trim(Str(CN)) & ":R" & Trim(Str(RN + 5)) & "C"
& Trim(Str(CN))
   CN = CN + 1
   i = 0
'
' Generate chart number character string
'
     Cname = "Chart" & Str(Nchart)
   Do Until i = 3
     i = i + 1
'
' Generate Y value data ranges and series labels
'
     Yrange(i) = Base & Trim(Str(RN)) & "C" & Trim(Str(YCN)) & ":R" & Trim(Str(RN + 5))
& "C" & Trim(Str(YCN))
     Sname(i) = Base & Trim(Str(RN)) & "C" & Trim(Str(CN - 4))
     RN = RN + 24
   Loop
'
' Build chart title
'
   Ctitle = "HUC" & Str(ID(3)) & " vs" & Str(ID(1)) & " &" & Str(ID(2)) & " - LA" & Str(LA)
& " Scenario" & Str(SCN)
'
' Generate line graph containing 3 series (representative vs 2 like areas)
' for each scenario within current like area group
'
   Charts.Add
   ActiveChart.ChartType = xlColumnClustered
   ActiveChart.SetSourceData Source:=Sheets("Outputs").Range( _
     EFrange), PlotBy:=xlColumns
   ActiveChart.SeriesCollection.NewSeries
   ActiveChart.SeriesCollection.NewSeries
   ActiveChart.SeriesCollection(1).XValues = Xrange
   ActiveChart.SeriesCollection(1).Values = Yrange(1)
```

```
    ActiveChart.SeriesCollection(1).Name = Sname(1)
    ActiveChart.SeriesCollection(2).Values = Yrange(2)
    ActiveChart.SeriesCollection(2).Name = Sname(2)
    ActiveChart.SeriesCollection(3).Values = Yrange(3)
    ActiveChart.SeriesCollection(3).Name = Sname(3)
    ActiveChart.Location Where:=xlLocationAsObject, Name:=ChtName
    With ActiveChart
      .HasTitle = True
      .ChartTitle.Characters.Text = Ctitle
      .Axes(xlCategory, xlPrimary).HasTitle = True
      .Axes(xlCategory, xlPrimary).AxisTitle.Characters.Text = "Run #"
      .Axes(xlValue, xlPrimary).HasTitle = True
      .Axes(xlValue, xlPrimary).AxisTitle.Characters.Text = Ytitle
    End With
'
' Move and increase the dimensions of each generated chart
'
    Windows("Like areas solns.xls").ScrollRow = 1
    ActiveWindow.Visible = False
    Windows("Like areas solns.xls").Activate
    Worksheets(ChtName).ChartObjects(Nchart).Activate
    ActiveChart.ChartArea.Select
    ActiveSheet.Shapes(Nchart).IncrementLeft IncLeft
    ActiveSheet.Shapes(Nchart).IncrementTop IncTop
    ActiveSheet.Shapes(Nchart).ScaleWidth 1.2, msoFalse, msoScaleFromTopLeft
    ActiveSheet.Shapes(Nchart).ScaleHeight 1.4, msoFalse, msoScaleFromTopLeft
    IncTop = IncTop + 255
    Nchart = Nchart + 1
  Loop
  Loop
'
' Define constants for next Effects Function data column
'
    Acode = Acode + 1           'increment ASCII code
    IncLeft = IncLeft + 400     'increment starting X-coord of 1st graph
  Loop
  Loop
End Sub
```

Appendix C

Table 5. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output A-EbTh-1	A-EbTh-2	A-EbTh-3	A-EbTh-4	A-EbTh-5
A	1	Abs	**.000***	**.029***	.361	.165	.594
		Rel	**.000***	**.035***	.543	.610	.785
	2	Abs	**.000***	.178	.627	.694	.986
		Rel	**.000***	.216	.741	.777	.986
	3	Abs	**.024***	.054	.063	.699	.234
		Rel	**.003***	.054	.139	.716	.234
	4	Abs	**.000***	.055	.210	**.030***	.260
		Rel	**.000***	.212	.337	.082	.512
B	1	Abs	**.000***	**.016***	.094	.235	.342
		Rel	**.000***	**.016***	.455	.140	.401
	2	Abs	**.000***	.061	.715	.397	.986
		Rel	**.000***	**.032***	.515	.428	.986
	3	Abs	**.001***	**.002***	.302	.272	.234
		Rel	**.001***	**.002***	.258	.228	.084
	4	Abs	**.000***	**.036***	.471	.079	.536
		Rel	**.000***	.177	.371	.088	.549
C	1	Abs	**.000***	**.019***	.110	.081	.602
		Rel	**.000***	**.037***	.518	**.008***	.242
	2	Abs	**.000***	.116	.345	.702	.821
		Rel	**.000***	.071	.345	.879	.821
	3	Abs	**.000***	.092	**.029***	**.040***	.084
		Rel	**.000***	**.010***	.191	.169	.400
	4	Abs	**.000***	**.036***	.503	.124	.089
		Rel	**.000***	.082	.147	.114	**.043***
D	1	Abs	**.001***	**.031***	**.003***	**.003***	.364
		Rel	**.000***	**.037***	**.003***	**.003***	.364
	2	Abs	**.001***	**.002***	**.022***	.119	.120
		Rel	**.000***	**.002***	**.022***	.119	.120
	3	Abs	**.001***	**.003***	.825	.354	.756
		Rel	**.000***	**.002***	.422	.163	.722
	4	Abs	**.001***	.187	**.003***	**.040***	.060
		Rel	**.000***	**.020***	**.003***	**.039***	.060

* significant $P \leq .05$

Table 6. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output A-HV-1	A-HV-2	A-HV-3	A-HV-4	A-HV-5
A	1	Abs	**.001***	**.019***	.139	.699	.096
		Rel	**.000***	**.031***	.611	.932	.566
	2	Abs	**.000***	**.007***	.062	.928	.071
		Rel	**.000***	.079	.177	.992	.125
	3	Abs	**.001***	**.037***	**.003***	.309	**.014***
		Rel	**.000***	**.021***	**.021***	.119	**.039***
	4	Abs	**.000***	**.037***	.058	.054	**.024***
		Rel	**.000***	**.021***	.093	.054	.130
B	1	Abs	**.000***	**.021***	**.012***	.216	**.003***
		Rel	**.001***	**.041***	.280	.472	**.029***
	2	Abs	**.000***	**.031***	**.029***	.954	**.002***
		Rel	**.001***	.200	.079	.974	**.006***
	3	Abs	**.000***	**.005***	**.001***	**.002***	**.001***
		Rel	**.001***	**.035***	**.001***	**.002***	**.001***
	4	Abs	**.000***	**.018***	**.013***	**.020***	**.000***
		Rel	**.001***	.125	**.021***	**.021***	**.003***
C	1	Abs	**.000***	**.021***	.140	.385	**.014***
		Rel	**.001***	**.021***	.171	**.016***	**.017***
	2	Abs	**.000***	**.032***	.096	.199	**.003***
		Rel	**.001***	**.009***	**.032***	**.033***	**.001***
	3	Abs	**.000***	.531	**.016***	**.014***	**.011***
		Rel	**.001***	**.011***	.072	.307	.063
	4	Abs	**.000***	**.021***	**.037***	**.024***	.186
		Rel	**.001***	**.041***	**.016***	**.009***	**.005***
D	1	Abs	**.001***	.155	.055	**.013***	.506
		Rel	**.000***	.171	**.016***	**.005***	.631
	2	Abs	**.000***	**.011***	.804	**.011***	.741
		Rel	**.000***	**.011***	.804	**.011***	.741
	3	Abs	**.000***	**.012***	.058	**.022***	.084
		Rel	**.000***	**.012***	.072	**.010***	.084
	4	Abs	**.000***	**.016***	.056	**.015***	.304
		Rel	**.000***	**.016***	.056	**.015***	.304

* significant $P \leq .05$

Table 7. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output A-NoA-A1	A-NoA-A2	A-NoA-A3	A-NoA-A4	A-NoA-A5
A	1	Abs	**.000***	**.000***	**.000***	**.001***	**.001***
		Rel	**.000***	**.019***	.139	.172	.209
	2	Abs	**.000***	**.000***	**.000***	**.000***	**.000***
		Rel	**.000***	**.031***	**.018***	**.018***	**.018***
	3	Abs	**.000***	**.001***	**.001***	**.001***	**.001***
		Rel	**.001***	**.011***	**.011***	**.001***	**.001***
	4	Abs	**.000***	**.000***	**.001***	**.001***	**.001***
		Rel	**.000***	**.031***	**.039***	**.032***	**.032***
B	1	Abs	**.000***	**.000***	**.001***	**.002***	**.003***
		Rel	**.000***	**.000***	**.001***	**.001***	**.001***
	2	Abs	**.000***	**.002***	**.001***	**.001***	**.002***
		Rel	**.000***	**.000***	**.000***	**.001***	**.001***
	3	Abs	**.000***	**.003***	**.003***	**.003***	**.001***
		Rel	**.000***	**.000***	**.001***	**.001***	**.001***
	4	Abs	**.000***	**.001***	**.003***	**.003***	**.003***
		Rel	**.000***	**.000***	**.001***	**.001***	**.001***
C	1	Abs	**.000***	**.002***	**.003***	**.003***	**.003***
		Rel	**.000***	**.018***	.140	.240	.229
	2	Abs	**.001***	**.002***	**.001***	**.002***	**.002***
		Rel	**.001***	**.050***	**.050***	**.050***	.051
	3	Abs	**.001***	**.003***	**.003***	**.003***	**.003***
		Rel	**.001***	**.001***	**.001***	**.002***	**.003***
	4	Abs	**.001***	**.002***	**.003***	**.003***	**.003***
		Rel	**.001***	**.023***	**.029***	**.024***	**.024***
D	1	Abs	**.000***	**.000***	**.000***	**.000***	**.000***
		Rel	**.000***	**.001***	**.003***	**.003***	**.003***
	2	Abs	**.000***	**.000***	**.000***	**.000***	**.000***
		Rel	**.000***	**.002***	**.002***	**.002***	**.002***
	3	Abs	**.000***	**.000***	**.001***	**.001***	**.000***
		Rel	**.000***	**.002***	**.003***	**.003***	**.002***
	4	Abs	**.000***	**.000***	**.000***	**.000***	**.000***
		Rel	**.000***	**.003***	**.002***	**.002***	**.002***

* significant $P \leq .05$

Table 8. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output A-NoA-F1	A-NoA-F2	A-NoA-F3	A-NoA-F4	A-NoA-F5
A	1	Abs	**.000***	**.001***	**.046***	**.149***	**.182***
		Rel	**.000***	**.001***	.112	.090	.090
	2	Abs	**.000***	**.031***	**.018***	**.043***	**.043***
		Rel	**.000***	**.023***	**.005***	**.005***	**.003***
	3	Abs	**.001***	**.001***	**.001***	**.003***	**.003***
		Rel	**.001***	**.001***	**.001***	**.002***	**.003***
	4	Abs	**.000***	**.019***	**.039***	**.050***	**.050***
		Rel	**.000***	**.023***	**.042***	**.032***	**.032***
B	1	Abs	**.000***	**.001***	**.004***	**.011***	**.022***
		Rel	**.000***	**.023***	.423	.343	.366
	2	Abs	**.000***	**.005***	**.001***	**.001***	**.002***
		Rel	**.001***	.057	**.018***	**.019***	**.032***
	3	Abs	**.000***	**.005***	**.002***	**.001***	**.002***
		Rel	**.004***	.113*	**.010***	**.010***	**.006***
	4	Abs	**.000***	**.005***	**.013***	**.022***	**.024***
		Rel	**.001***	.162	.202	.140	.182
C	1	Abs	**.000***	**.000***	**.001***	**.002***	**.002***
		Rel	**.001***	**.002***	**.050***	.064	.097
	2	Abs	**.000***	**.000***	**.001***	**.001***	**.001***
		Rel	**.001***	**.015***	**.007***	**.005***	**.009***
	3	Abs	**.000***	**.001***	**.001***	**.001***	**.001***
		Rel	**.001***	**.003***	**.002***	**.005***	**.010***
	4	Abs	**.000***	**.001***	**.001***	**.001***	**.001***
		Rel	**.001***	.058	**.050***	.052	.052
D	1	Abs	**.000***	**.001***	**.001***	**.001***	**.001***
		Rel	**.000***	**.000***	**.001***	**.003***	**.003***
	2	Abs	**.000***	**.000***	**.000***	**.000***	**.000***
		Rel	**.000***	**.001***	**.001***	**.001***	**.001***
	3	Abs	**.000***	**.000***	**.001***	**.001***	**.001***
		Rel	**.000***	**.001***	**.001***	**.001***	**.001***
	4	Abs	**.000***	**.001***	**.001***	**.001***	**.001***
		Rel	**.000***	**.001***	**.002***	**.002***	**.002***

* significant $P \leq .05$

Table 9. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output ASz-LG5	ASz-LS5	ASz-MD5	ASz-MS5	ASz-PL5
A	1	Abs	**.005***	**.008***	**.001***	**.001***	**.001***
		Rel	.142	**.046***	**.004***	**.000***	**.013***
	2	Abs	**.007***	**.035***	**.001***	**.000***	**.001***
		Rel	.264	**.038***	**.003***	**.000***	**.005***
	3	Abs	**.002***	**.022***	**.001***	**.003***	**.001***
		Rel	**.013***	**.002***	**.001***	**.003***	**.025***
	4	Abs	**.019***	**.042***	**.001***	**.000***	**.002***
		Rel	.118	**.029***	**.002***	**.000***	**.008***
B	1	Abs	.181	**.001***	**.001***	**.009***	**.001***
		Rel	.692	**.002***	**.034***	.119	**.019***
	2	Abs	**.034***	**.001***	**.001***	**.003***	**.000***
		Rel	**.019***	**.002***	.124	**.001***	**.001***
	3	Abs	**.002***	**.001***	**.001***	**.034***	.134
		Rel	**.028***	**.001***	.069	.078	**.001***
	4	Abs	**.008***	**.001***	**.002***	.054	**.000***
		Rel	**.021***	**.003***	**.033***	**.019***	**.016***
C	1	Abs	**.011***	**.001***	**.001***	**.001***	**.001***
		Rel	**.022***	**.003***	**.015***	.080	**.003***
	2	Abs	**.003***	**.003***	**.000***	**.002***	**.000***
		Rel	**.011***	.066	**.014***	.328	**.000***
	3	Abs	**.003***	**.001***	**.001***	**.001***	**.001***
		Rel	.077	**.021***	**.001***	.082	**.001***
	4	Abs	**.002***	**.013***	**.001***	**.003***	**.001***
		Rel	**.009***	**.039***	**.018***	.459	**.001***
D	1	Abs	**.000***	**.000***	**.003***	**.007***	**.000***
		Rel	**.000***	**.002***	**.002***	**.011***	**.000***
	2	Abs	**.000***	**.000***	**.002***	**.026***	**.001***
		Rel	**.000***	**.000***	**.000***	**.004***	**.001***
	3	Abs	**.001***	**.000***	**.003***	**.033***	**.003***
		Rel	**.001***	**.003***	**.003***	**.016***	**.003***
	4	Abs	**.000***	**.000***	**.003***	**.033***	**.003***
		Rel	**.000***	**.003***	**.003***	**.017***	**.001***

* significant $P \leq .05$

Table 10. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 4 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output ASz-PT5	ASz-SS5	ASz-VL5	ASz-VS5
A	1	Abs	**.014***	**.028***	1.000	.119
		Rel	.612	**.030***	1.000	.119
	2	Abs	**.001***	**.044***	1.000	.368
		Rel	**.022***	**.026***	1.000	.368
	3	Abs	**.005***	**.042***	1.000	1.000
		Rel	**.005***	**.022***	1.000	1.000
	4	Abs	**.002***	.055	1.000	.368
		Rel	**.008***	**.044***	1.000	.368
B	1	Abs	**.008***	.310	1.000	1.000
		Rel	.264	.647	1.000	1.000
	2	Abs	**.000***	**.036***	1.000	1.000
		Rel	**.001***	.126	1.000	1.000
	3	Abs	**.001***	.140	1.000	1.000
		Rel	**.030***	.143	1.000	1.000
	4	Abs	**.001***	**.040***	1.000	1.000
		Rel	.587	**.037***	1.000	1.000
C	1	Abs	**.001***	.310	1.000	1.000
		Rel	**.017***	.651	1.000	1.000
	2	Abs	**.003***	**.036***	1.000	1.000
		Rel	**.005***	.160	1.000	1.000
	3	Abs	**.002***	.107	1.000	1.000
		Rel	.095	.384	1.000	1.000
	4	Abs	**.001***	.280	1.000	1.000
		Rel	**.003***	.085	1.000	1.000
D	1	Abs	**.017***	.368	1.000	1.000
		Rel	**.005***	.368	1.000	1.000
	2	Abs	**.001***	.586	1.000	1.000
		Rel	**.001***	.586	1.000	1.000
	3	Abs	**.001***	.326	1.000	1.000
		Rel	**.000***	.326	1.000	1.000
	4	Abs	**.001***	.586	1.000	1.000
		Rel	**.001***	.586	1.000	1.000

* significant $P \leq .05$

Table 11. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output A-ECCA-1	A-ECCA-2	A-ECCA-3	A-ECCA-4	A-ECCA-5
A	1	Abs	**.001***	**.035***	.209	.366	.414
		Rel	**.000***	**.019***	.076	.268	.268
	2	Abs	**.000***	**.011***	**.011***	**.016***	**.021***
		Rel	**.000***	.258	.287	.355	.267
	3	Abs	**.001***	**.004***	**.035***	**.045***	.051
		Rel	**.000***	**.006***	**.019***	**.022***	**.022***
	4	Abs	**.000***	**.019***	**.049***	.074	.164
		Rel	**.000***	**.019***	.239	.164	.148
B	1	Abs	**.000***	**.001***	**.008***	**.005***	**.007***
		Rel	**.000***	**.018***	.075	.171	.171
	2	Abs	**.000***	**.001***	**.005***	**.005***	**.004***
		Rel	**.000***	.074	.102	.060	**.035***
	3	Abs	**.000***	**.002***	**.001***	**.002***	**.004***
		Rel	**.000***	**.005***	**.022***	**.022***	**.039***
	4	Abs	**.000***	**.001***	**.003***	**.004***	**.004***
		Rel	**.000***	**.034***	.149	.201	.066
C	1	Abs	**.000***	**.001***	**.002***	**.002***	**.005***
		Rel	**.000***	**.018***	.150	.148	.209
	2	Abs	**.000***	**.003***	**.003***	**.003***	**.003***
		Rel	**.001***	**.012***	.074	.074	**.044***
	3	Abs	**.000***	**.001***	**.001***	**.001***	**.002***
		Rel	**.002***	**.001***	**.005***	**.022***	**.022***
	4	Abs	**.000***	**.001***	**.002***	**.003***	**.003***
		Rel	**.001***	**.019***	.142	.220	.135
D	1	Abs	**.001***	**.003***	.268	.200	.268
		Rel	**.000***	**.003***	**.014***	**.014***	**.019***
	2	Abs	**.000***	**.048***	**.011***	**.048***	.124
		Rel	**.000***	**.002***	**.002***	**.002***	**.003***
	3	Abs	**.000***	**.009***	**.037***	**.049***	.126
		Rel	**.000***	**.002***	**.002***	**.002***	**.003***
	4	Abs	**.001***	**.005***	**.023***	**.030***	**.023***
		Rel	**.000***	**.002***	**.002***	**.002***	**.003***

* significant $P \leq .05$

Table 12. Asymptotic Significance of Kruskal-Wallis Tests for 5 Effect Function Outputs by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output C-EcTh-1	C-EcTh-2	C-EcTh-3	C-EcTh-4	C-EcTh-5
A	1	Abs	**.000***	**.034***	.368	.135	.286
		Rel	**.000***	**.035***	.543	.895	.895
	2	Abs	**.000***	.177	.617	.744	.894
		Rel	**.000***	.195	.828	.690	.777
	3	Abs	**.024***	.363	.057	.728	.343
		Rel	**.003***	.179	.120	.600	.281
	4	Abs	**.000***	.054	.180	**.019***	.308
		Rel	**.000***	.210	.384	.052	.523
B	1	Abs	**.000***	**.020***	.146	.241	.239
		Rel	**.000***	.054	.395	.484	.579
	2	Abs	**.000***	.054	.520	.770	.986
		Rel	**.000***	.210	.574	.708	.986
	3	Abs	**.001***	**.002***	.778	.429	.390
		Rel	**.001***	**.005***	.504	.400	.192
	4	Abs	**.000***	**.035***	.397	.063	.536
		Rel	**.000***	.061	.383	.134	.662
C	1	Abs	**.000***	**.020***	.137	.112	.121
		Rel	**.000***	**.034***	.518	**.006***	**.049***
	2	Abs	**.000***	.116	.251	.678	.724
		Rel	**.000***	.071	.185	.713	.741
	3	Abs	**.000***	.092	**.028***	**.040***	**.038***
		Rel	**.000***	**.018***	.166	.080	.102
	4	Abs	**.000***	**.034***	.628	**.027***	.353
		Rel	**.000***	.157	.179	.076	.311
D	1	Abs	**.001***	**.032***	**.003***	**.008***	.164
		Rel	**.000***	**.038***	**.003***	**.008***	.164
	2	Abs	**.001***	**.002***	**.004***	.363	.120
		Rel	**.000***	**.002***	**.004***	.363	.120
	3	Abs	**.001***	**.005***	.500	.337	.815
		Rel	**.000***	**.003***	.192	.206	.722
	4	Abs	**.001***	.253	**.004***	.066	.164
		Rel	**.000***	**.019***	**.004***	**.040***	.164

* significant $P \leq .05$

Table 13. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output h_vol_1	h_vol_2	h_vol_3	h_vol_4	h_vol_5
A	1	Abs	**.000***	**.015***	.111	.528	.149
		Rel	**.000***	**.024***	.193	.994	.849
	2	Abs	**.000***	**.007***	.215	.967	.161
		Rel	**.000***	.079	.236	.967	.179
	3	Abs	**.000***	**.037***	**.027***	.459	**.049***
		Rel	**.000***	**.028***	**.036***	.240	.064
	4	Abs	**.000***	**.017***	.074	.529	.115
		Rel	**.000***	**.017***	.112	.233	.219
B	1	Abs	**.000***	**.017***	.089	.147	**.029***
		Rel	**.000***	**.017***	.111	.481	.172
	2	Abs	**.000***	.066	.157	.993	.122
		Rel	**.000***	.290	.234	.974	.151
	3	Abs	**.000***	**.039***	**.004***	**.006***	**.003***
		Rel	**.000***	**.035***	**.019***	**.022***	.051
	4	Abs	**.000***	**.015***	**.047***	**.045***	**.017***
		Rel	**.000***	**.017***	.052	**.029***	**.034***
C	1	Abs	**.000***	**.024***	.165	.195	**.026***
		Rel	**.000***	**.017***	.201	**.010***	.057
	2	Abs	**.000***	**.028***	.120	.188	.120
		Rel	**.000***	**.006***	.210	.064	.122
	3	Abs	**.000***	.173	**.045***	.051	**.029***
		Rel	**.000***	**.006***	.080	.097	.067
	4	Abs	**.000***	**.017***	.056	**.024***	.235
		Rel	**.000***	**.017***	**.045***	**.021***	**.027***
D	1	Abs	**.000***	.168	**.030***	**.038***	.627
		Rel	**.000***	**.033***	**.015***	**.017***	.631
	2	Abs	**.000***	**.010***	.804	**.011***	.741
		Rel	**.000***	**.010***	**.804***	.011	.741
	3	Abs	**.000***	**.042***	.072	**.022***	.076
		Rel	**.000***	**.042***	.068	**.022***	.109
	4	Abs	**.000***	**.015***	.056	**.015***	.304
		Rel	**.000***	**.015***	.056	**.015***	.250

* significant $P \leq .05$

Table 14. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output A-HdCv-1	A-HdCv-2	A-HdCv-3	A-HdCv-4	A-HdCv-5
A	1	Abs	.000*	.000*	.001*	.001*	.001*
		Rel	.000*	.000*	.001*	.001*	.001*
	2	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*
	3	Abs	.000*	.001*	.001*	.001*	.001*
		Rel	.000*	.001*	.001*	.001*	.001*
	4	Abs	.001*	.000*	.001*	.000*	.000*
		Rel	.000*	.000*	.001*	.000*	.000*
B	1	Abs	.000*	.000*	.000*	.001*	.001*
		Rel	.000*	.000*	.000*	.001*	.001*
	2	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.001*	.002*	.002*
	3	Abs	.000*	.000*	.001*	.000*	.001*
		Rel	.000*	.000*	.003*	.003*	.002*
	4	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.001*	.003*
C	1	Abs	.000*	.000*	.000*	.001*	.001*
		Rel	.000*	.000*	.000*	.001*	.001*
	2	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.001*
	3	Abs	.000*	.001*	.001*	.001*	.001*
		Rel	.000*	.001*	.001*	.001*	.001*
	4	Abs	.000*	.000*	.001*	.001*	.001*
		Rel	.000*	.000*	.001*	.001*	.001*
D	1	Abs	.001*	.001*	.000*	.001*	.003*
		Rel	.000*	.000*	.000*	.000*	.000*
	2	Abs	.001*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*
	3	Abs	.000*	.000*	.000*	.001*	.000*
		Rel	.000*	.000*	.000*	.001*	.000*
	4	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*

* significant $P \leq .05$

Table 15. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output C-NtVl-1	C-NtVl -2	C-NtVl -3	C-NtVl -4	C-NtVl -5
A	1	Abs	**.000***	**.037***	.399	.312	.444
		Rel	**.000***	**.038***	.612	.402	.414
	2	Abs	**.001***	.267	.201	.391	.092
		Rel	**.000***	.223	.323	.391	.244
	3	Abs	**.029***	.223	.076	.927	.399
		Rel	**.022***	.268	.064	.884	.241
	4	Abs	**.004***	.057	.402	.585	.097
		Rel	**.011***	.268	.343	.456	.228
B	1	Abs	**.000***	.057	.484	.612	.055
		Rel	**.001***	.180	.641	.623	.135
	2	Abs	**.000***	.290	.058	.746	.231
		Rel	**.001***	.290	**.037***	.746	**.046***
	3	Abs	**.028***	.060	**.034***	.205	.076
		Rel	**.032***	.149	.080	.523	.078
	4	Abs	**.001***	**.006***	.716	.325	**.033***
		Rel	**.001***	**.045***	.622	.296	**.033***
C	1	Abs	**.000***	**.038***	.342	.864	.423
		Rel	**.001***	.180	.622	.343	.278
	2	Abs	**.001***	.315	**.025***	.118	.162
		Rel	**.001***	.261	**.033***	.074	.236
	3	Abs	**.001***	.223	.058	.205	.140
		Rel	**.001***	.147	.191	.994	.202
	4	Abs	**.000***	.059	.652	.267	.141
		Rel	**.001***	**.022***	.522	.103	.074
D	1	Abs	**.000***	.126	**.013***	**.050***	.577
		Rel	**.000***	.063	**.005***	.063	.577
	2	Abs	**.008***	**.002***	.121	.304	.565
		Rel	**.001***	**.002***	.121	.304	.565
	3	Abs	**.017***	**.006***	.484	.094	.508
		Rel	**.001***	**.004***	.641	.090	.731
	4	Abs	**.004***	.288	.076	.054	.948
		Rel	**.028***	.288	.062	.054	.948

* significant $P \leq .05$

Table 16. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output I-Pltd-1	I-Pltd-2	I-Pltd-3	I-Pltd-4	I-Pltd-5
A	1	Abs	.000*	.000*	.000*	.002*	.003*
		Rel	.001*	.000*	.001*	.003*	.001*
	2	Abs	.000*	.000*	.000*	.001*	.001*
		Rel	.001*	.000*	.000*	.001*	.000*
	3	Abs	.001*	.001*	.000*	.003*	.003*
		Rel	.002*	.001*	.001*	.001*	.001*
	4	Abs	.000*	.000*	.000*	.002*	.001*
		Rel	.000*	.000*	.001*	.001*	.001*
B	1	Abs	.001*	.001*	.002*	.002*	.001*
		Rel	.000*	.001*	.001*	.001*	.001*
	2	Abs	.001*	.000*	.000*	.001*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*
	3	Abs	.001*	.001*	.001*	.001*	.001*
		Rel	.000*	.000*	.001*	.001*	.001*
	4	Abs	.001*	.001*	.001*	.002*	.001*
		Rel	.000*	.000*	.001*	.001*	.001*
C	1	Abs	.000*	.001*	.001*	.001*	.001*
		Rel	.002*	.001*	.001*	.001*	.001*
	2	Abs	.001*	.000*	.000*	.001*	.001*
		Rel	.000*	.000*	.000*	.001*	.001*
	3	Abs	.002*	.001*	.000*	.003*	.003*
		Rel	.001*	.001*	.000*	.001*	.002*
	4	Abs	.001*	.003*	.000*	.002*	.001*
		Rel	.001*	.000*	.000*	.001*	.001*
D	1	Abs	.000*	.000*	.000*	.002*	.000*
		Rel	.001*	.000*	.000*	.000*	.000*
	2	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*
	3	Abs	.000*	.002*	.003*	.003*	.001*
		Rel	.000*	.000*	.000*	.000*	.000*
	4	Abs	.000*	.001*	.001*	.002*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*

* significant $P \leq .05$

Table 17. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output - I-RISK-1	I-RISK-2	I-RISK-3	I-RISK-4	I-RISK-5
A	1	Abs	.000*	.000*	.001*	.001*	.001*
		Rel	.001*	.013*	.051	.104	.112
	2	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.001*	.031*	.030*	.030*	.033*
	3	Abs	.000*	.000*	.001*	.001*	.001*
		Rel	.003*	.003*	.001*	.003*	.003*
	4	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.031*	.047*	.047*	.046*
B	1	Abs	.000*	.000*	.000*	.001*	.001*
		Rel	.000*	.001*	.005*	.015*	.015*
	2	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.003*	.003*	.003*	.003*
	3	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.006*	.006*	.006*	.008*
	4	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.003*	.004*	.003*	.003*
C	1	Abs	.001*	.002*	.002*	.003*	.003*
		Rel	.000*	.000*	.001*	.002*	.002*
	2	Abs	.001*	.002*	.002*	.002*	.002*
		Rel	.000*	.001*	.001*	.001*	.001*
	3	Abs	.001*	.002*	.003*	.003*	.003*
		Rel	.000*	.000*	.001*	.001*	.001*
	4	Abs	.001*	.001*	.003*	.003*	.003*
		Rel	.000*	.000*	.001*	.001*	.001*
D	1	Abs	.000*	.000*	.000*	.001*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*
	2	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*
	3	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*
	4	Abs	.000*	.000*	.000*	.000*	.000*
		Rel	.000*	.000*	.000*	.000*	.000*

* significant $P \leq .05$

Table 18. Asymptotic Significance Probabilities of Kruskal-Wallis Tests for 5 Effect Function Outputs (Absolute and Relative) by Like Area Group and Scenario number.

LA Group	Scenario #		Effect Function Output A-Thrm-1	A-Thrm-2	A-Thrm-3	A-Thrm-4	A-Thrm-5
A	1	Abs	**.000***	**.001***	**.003***	**.015***	**.008***
		Rel	**.000***	**.002***	.075	.109	.090
	2	Abs	**.001***	**.036***	**.036***	**.011***	**.001***
		Rel	**.001***	.106	.106	.117	**.006***
	3	Abs	**.000***	**.000***	**.000***	**.000***	**.000***
		Rel	**.000***	**.000***	**.000***	**.002***	**.001***
	4	Abs	**.000***	**.001***	**.044***	.072	**.002***
		Rel	**.000***	**.001***	.894	.429	**.035***
B	1	Abs	**.001***	**.000***	**.001***	**.002***	**.001***
		Rel	**.003***	**.006***	**.020***	**.024***	**.006***
	2	Abs	**.020***	**.001***	**.003***	**.000***	**.000***
		Rel	**.027***	**.002***	**.003***	**.001***	**.001***
	3	Abs	**.000***	**.000***	**.001***	**.000***	**.000***
		Rel	**.000***	**.000***	**.001***	**.002***	**.049***
	4	Abs	**.001***	**.001***	**.003***	**.001***	**.001***
		Rel	**.016***	**.001***	**.006***	**.001***	**.003***
C	1	Abs	**.007***	**.001***	**.001***	**.003***	**.003***
		Rel	**.019***	**.001***	**.016***	.414	.236
	2	Abs	**.003***	.160	**.001***	**.000***	**.001***
		Rel	**.003***	**.016***	**.028***	**.002***	**.002***
	3	Abs	**.000***	**.000***	**.000***	**.003***	**.003***
		Rel	**.000***	**.000***	**.000***	.521	.262
	4	Abs	**.024***	**.002***	**.002***	**.001***	**.001***
		Rel	**.003***	**.003***	.059	**.032***	.645
D	1	Abs	**.000***	**.000***	**.000***	**.000***	**.001***
		Rel	**.000***	**.000***	**.000***	**.000***	**.000***
	2	Abs	**.000***	**.002***	**.002***	**.000***	**.001***
		Rel	**.000***	**.002***	**.000***	**.000***	**.001***
	3	Abs	**.000***	**.000***	**.002***	**.000***	**.001***
		Rel	**.000***	**.000***	**.000***	**.000***	**.000***
	4	Abs	**.000***	**.000***	**.003***	**.002***	**.002***
		Rel	**.000***	**.000***	**.001***	**.000***	**.001***

* significant $P \leq .05$